Indirect Dark Matter Searches with VERITAS

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The Very Energetic Radiation Imaging Telescope Array

Instrument:

- Four 12-m telescopes
- 500-pixel cameras (3.5° FoV)
- FLWO, Mt. Hopkins, Az (1268 m)

Currently the worlds most sensitive Imaging Atmospheric Cherenkov Telescope (IACT) array

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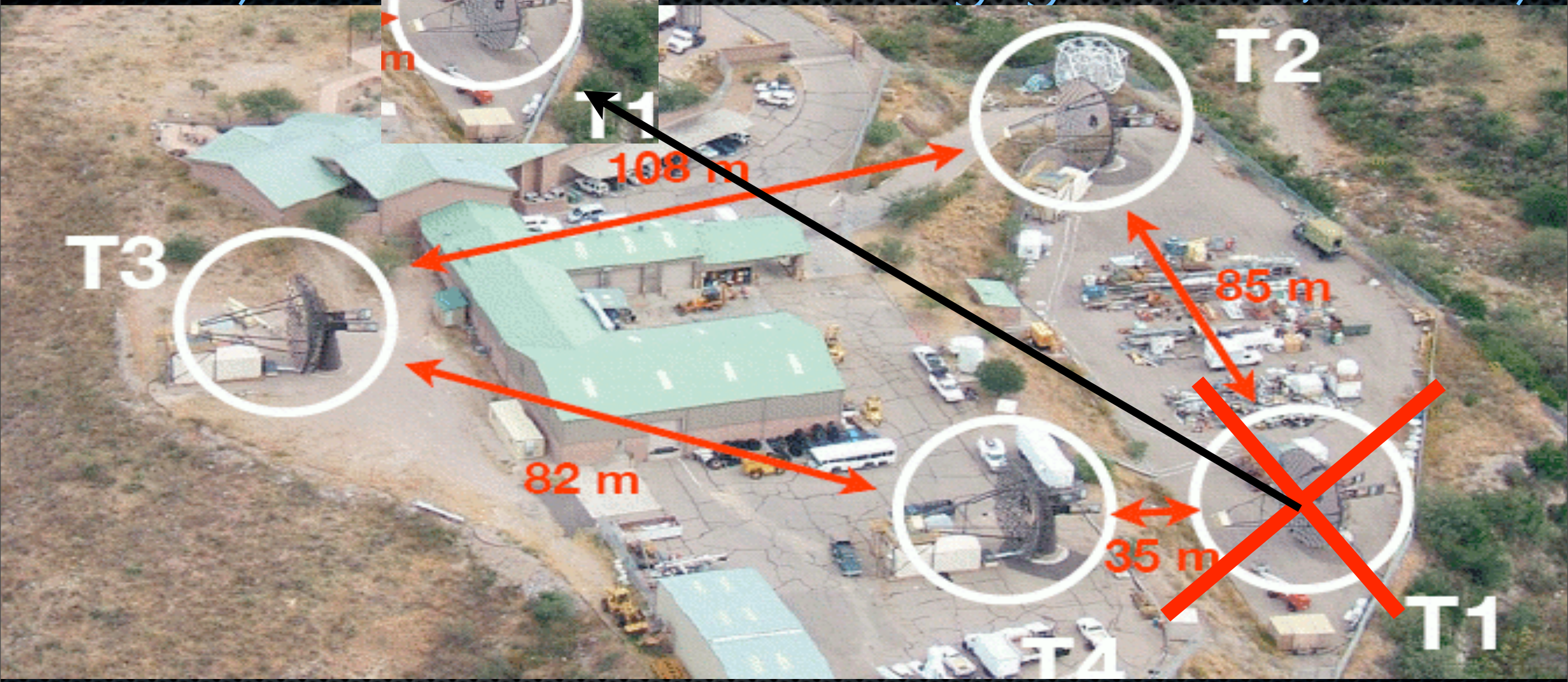
The Very Ene diation Imaging Telescope Array



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VERITAS

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* energy range: 100 GeV to >30 TeV (spectral reconstruction starts at 150 GeV)
* energy resolution: 15% at 1 TeV
* angular resolution: <0.1 deg at 1 TeV, 0.14 deg at 200 GeV (68% values)
* source location accuracy: 90 arcseconds
* point source sensitivity: 1% Crab in ~~< 50h~~ 30h, 10% in ~~45~~ 30min
* observation time per year: 750 hours non-moonlight, 100 hours moonlight

Dark Matter Searches

-WIMPs in mass range of 50 GeV-10 TeV are well motivated DM candidates

-Self annihilation of neutralino in this mass range leads to GeV-TeV gamma-rays (spectral cutoff@WIMP mass or "line" signature)

-FERMI+VERITAS are complimentary and are well suited for search

Gamma-ray Signal from DM:

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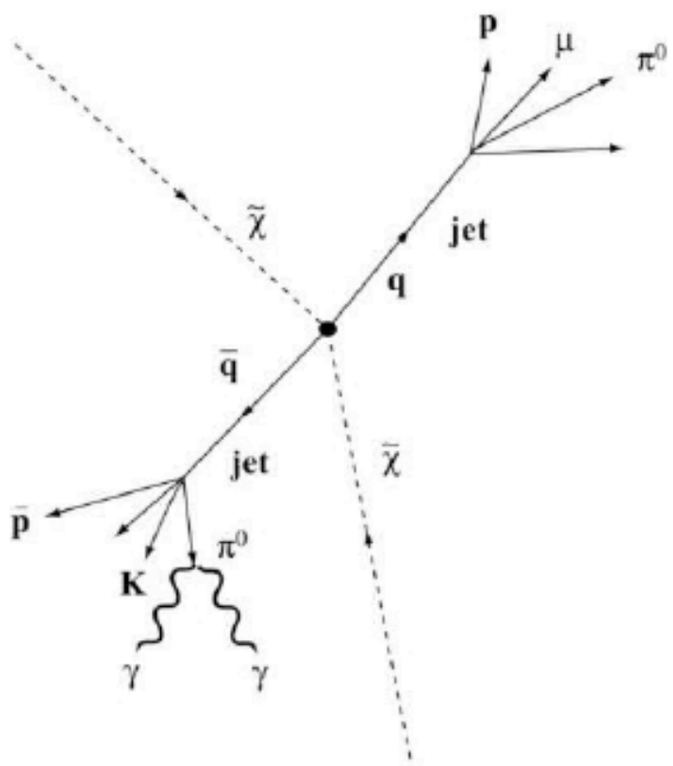
Particle Physics | Astrophysics

$$\frac{d\phi(E,\vec{\psi},\Delta\Omega)}{dE} = \left[\frac{\langle\sigma v\rangle}{8\pi m_\chi^2}\frac{dN(E,m_\chi)}{dE}\right] J(\vec{\psi},\Delta\Omega)$$

- Hadronization of final state pairs produces continuum gamma-ray emission
- WIMP Model Parameter Space
  - m_x = 100 GeV - 10 TeV
  - $\langle\sigma v\rangle$ = ~3 x 10^{-26} cm^3 s^{-1}



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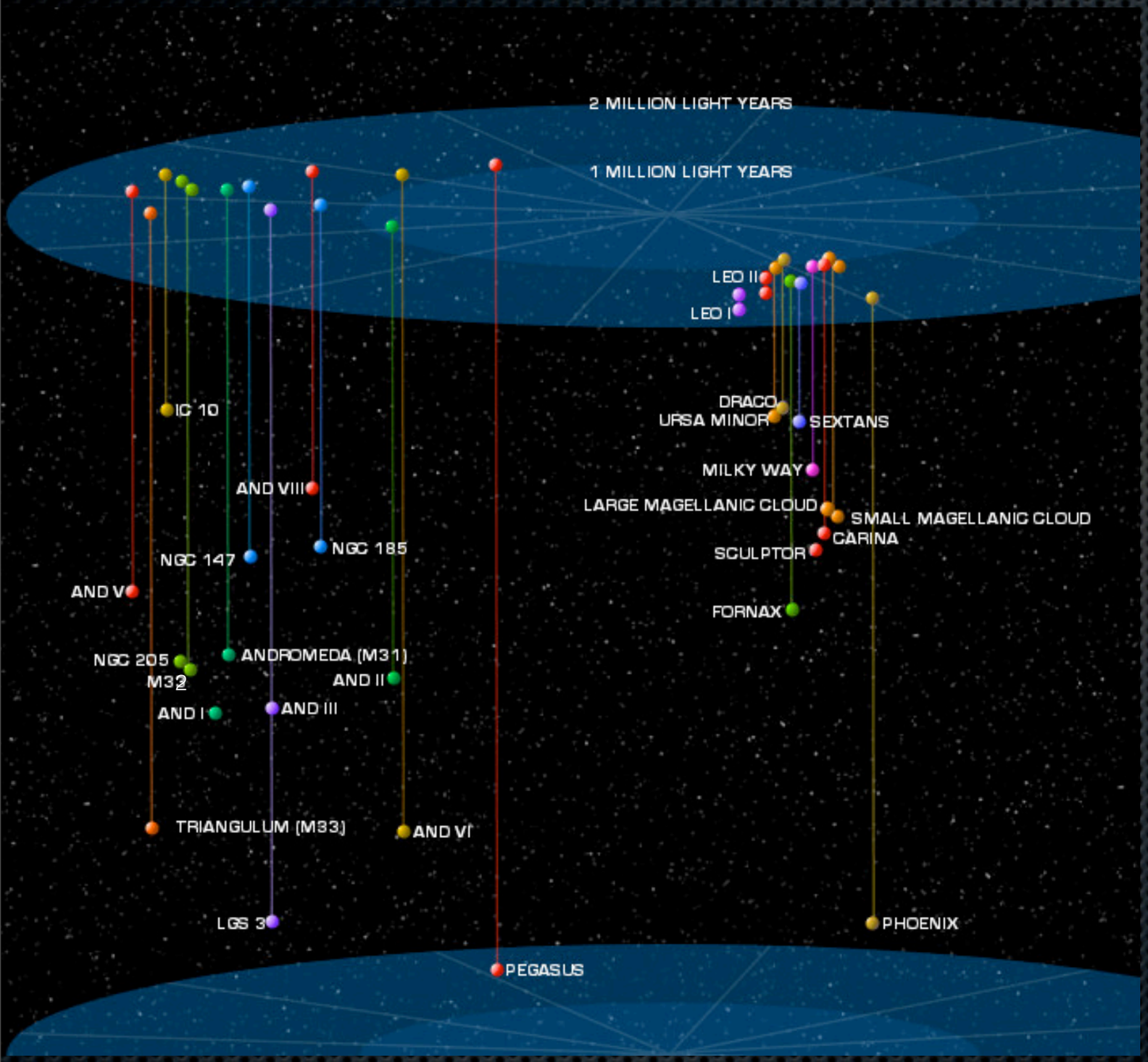
- Line of sight integration over target region gives astrophysical contribution
- Proportional to density squared – sensitive to small scale enhancements in the DM density

$$J(\vec{\psi},\Delta\Omega) = \left(\frac{1}{\rho_c^2 R_H}\right)\int_{\Delta\Omega} d\Omega \int \rho^2 ds(\vec{\psi})$$

Targets:



- Local Galaxies:

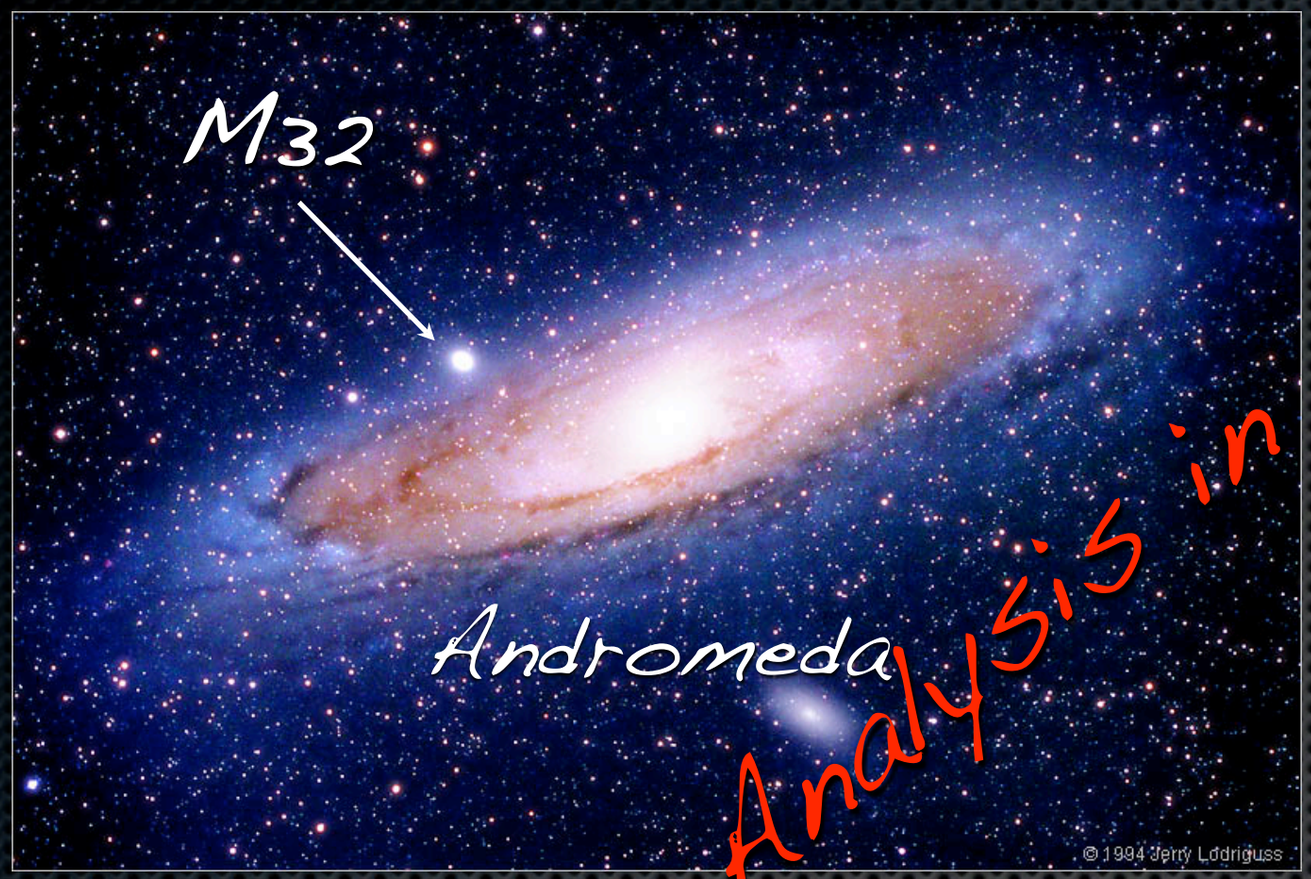
M32, M33

- DSphs: Ursa Minor, Draco, Willman I, Bootes I

- Globular Cluster:

M5

Targets: Galaxies M32/M33



-"Cuspy" stellar profiles

-Baryon+DM interaction could compress halo + generate large boost factor for signal

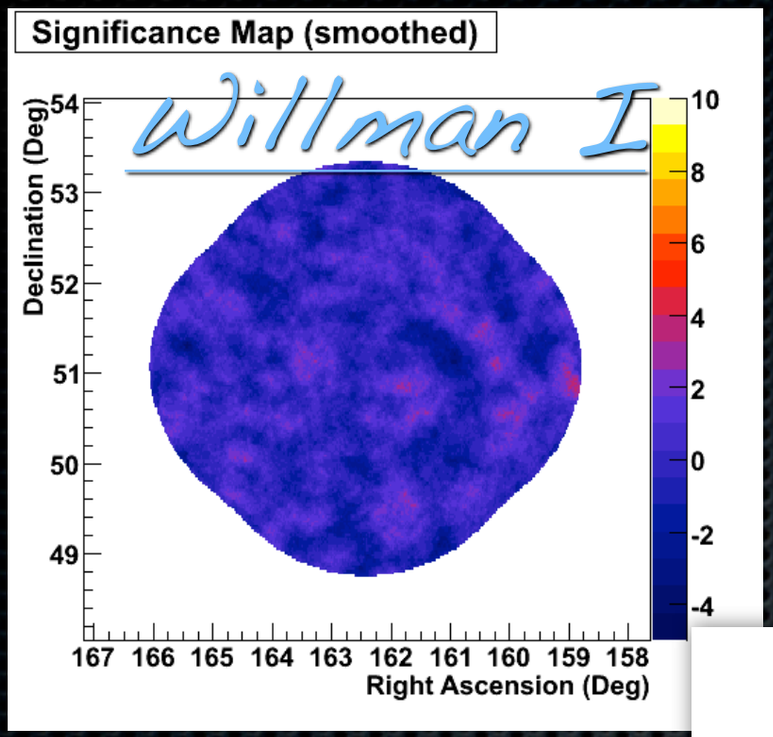
on: Large astrophysical background, interpretation difficult....

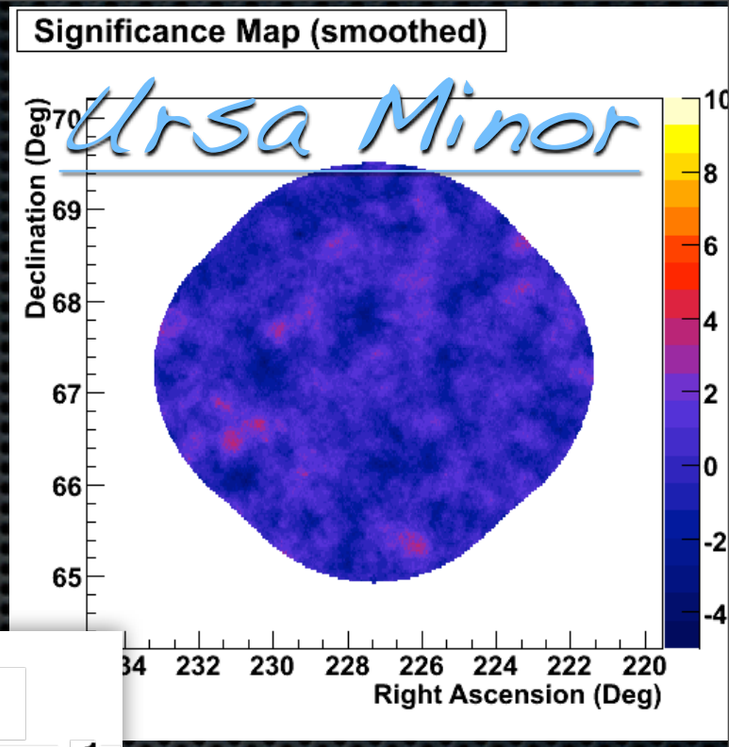
Targets: Dwarf Galaxies

-Very high mass/light ratio (DM dominated)

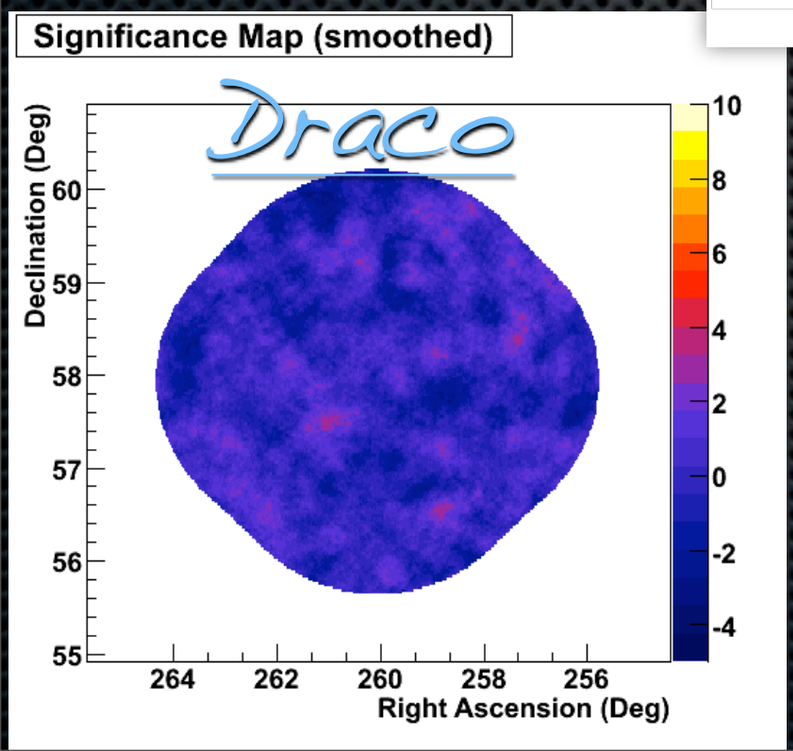
-Very close

-Low astrophysical source confusion (can probably attribute any signal to DM)





	Exposure [h]	95% C.L. Flux UL at 1 TeV [m^{-2} s^{-1} TeV^{-1}]
Draco	19.1	1.0×10^{-9}
Ursa Minor	19.4	1.6×10^{-9}
Willman I	14.4	2.6×10^{-9}
Bootes I	15.4	1.5×10^{-9}

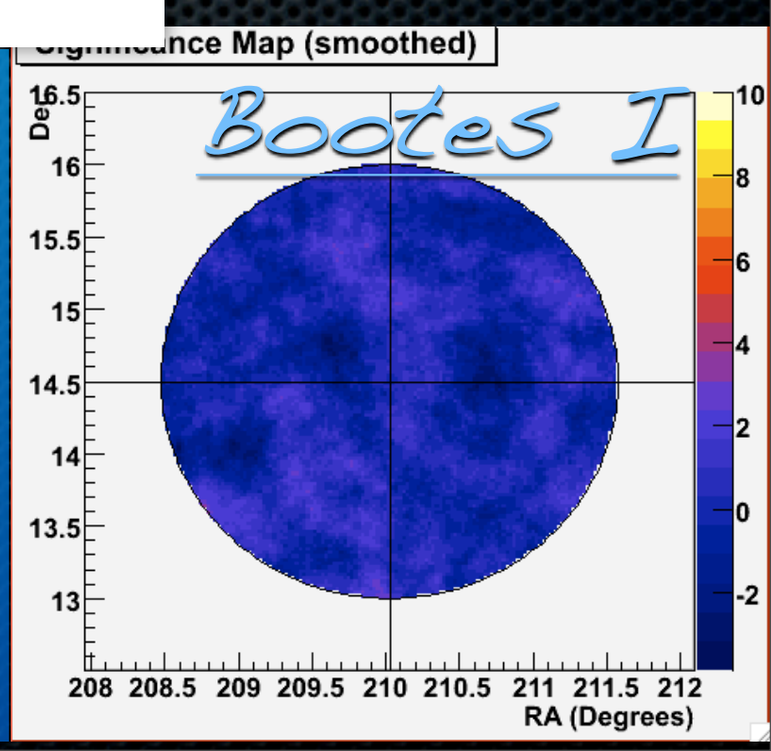


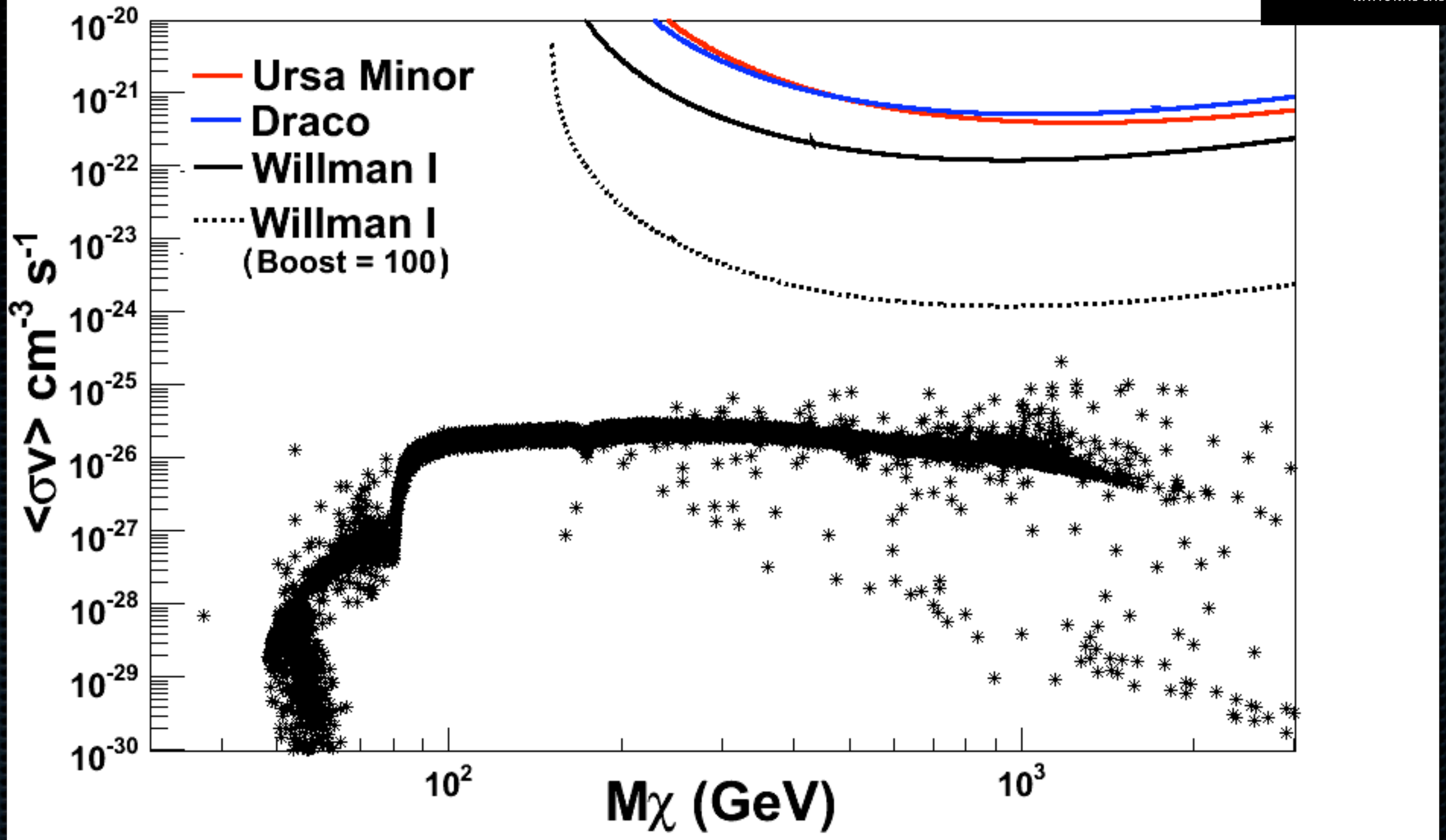
~1% Crab

Most Sensitive

IACT

limits to date





-Need significant boost factor (~1000) to constrain models

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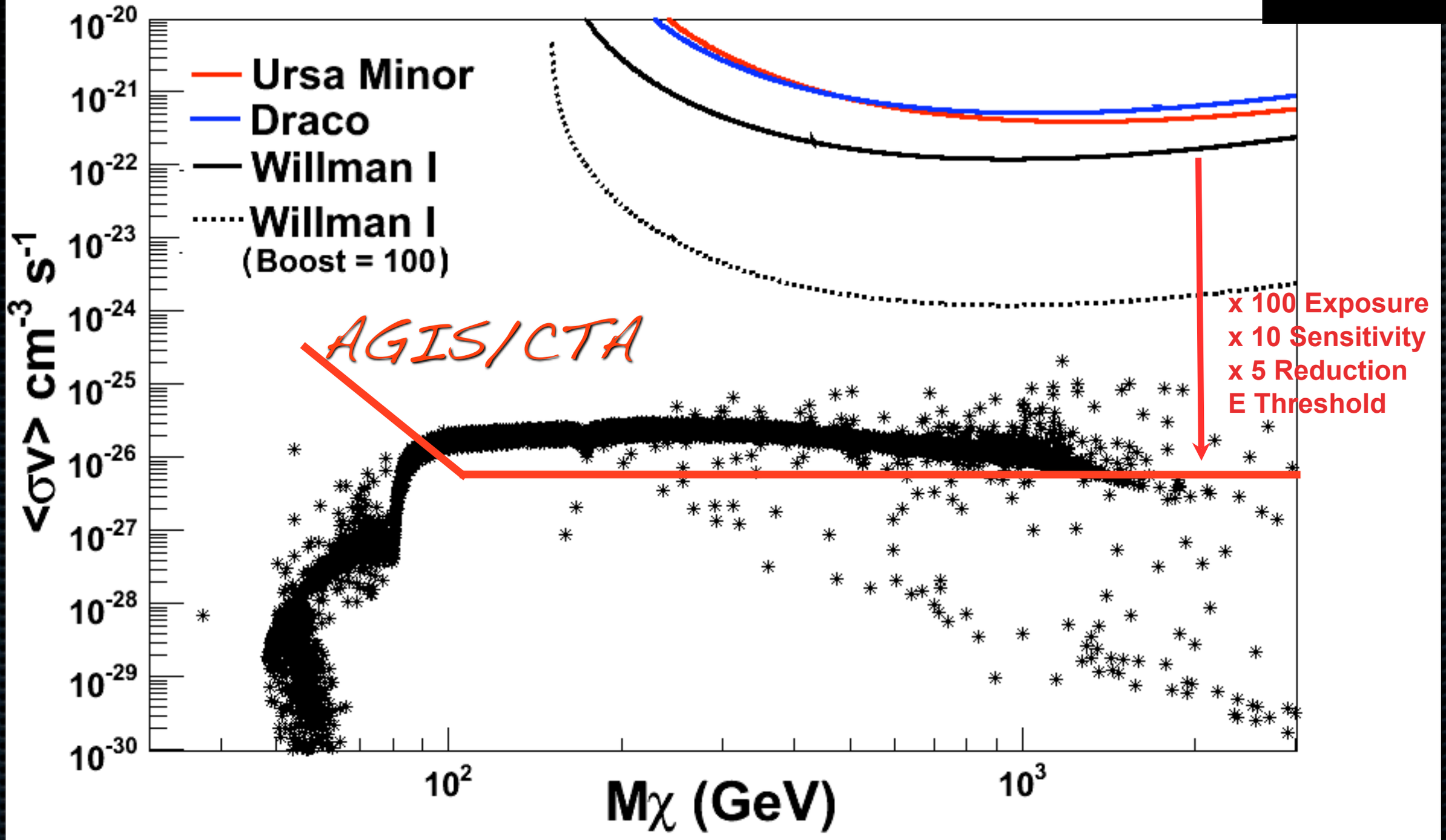

AGIS/CTA can significantly constrain models

AGIS: Advanced Gamma-ray Imaging System

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-Development of future IACT observatory is currently pursued in both US (AGIS) and Europe (CTA) with the prospect for a joint instrument

-With a dedicated dwarf galaxy observing program (1000h) a next-generation IACT could rule out a significant fraction of the MSSM parameter space

-AGIS (US contribution) is a 36-telescope array employing novel optical design which combines large FoV (~8°) and good angular resolution (~4')

Future DM work:

-Observations continue.....

-Possibility of source stacking to increase constraint

-Results from observations of globular clusters and other dwarves.

-Future IACTs+Fermi will be in position to constrain models/(detect!)